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Brylova L. [1], *Priemets O.* [2]

[1, 2] International Education Corporation
(Kazakh Leading Academy of Architecture and Civil Engineering),
Almaty, Republic of Kazakhstan

E-mail: [1]*larisa.brulova@gmail.com,* [2]*oksana.priemets@mail.ru*

ARCHITECTURE OF UNDERGROUND SPACES

Abstract. The use of underground space planning and building of large cities is of paramount importance due to the shortage of urban areas, the constant population growth and a sharp increase in gas content, and traffic in the streets, and insufficient development of urban infrastructure. With the rapid growth of cities and the territories occupied by them, damaging levels of motorization requirements increase speeds while increasing its security problem of maintaining support capital development and the natural environment can be resolved only through broad and systematic development and use of underground spaces. Over the past decades, the development of underground space in many countries of the world has become a developed industry. It solves three main tasks: unloads traffic flows, allows using underground floors to erect high-rise buildings and expand the useful space of the house due to the device of the operated premises.

Keywords: design, city, space, architecture, underground complexes, urban development, ecology, perspective, innovative technologies, motorization, space, transport

Брылова Л. С. [1], *Приемец О. Н.* [2]

[1, 2] Международная Образовательная Корпорация
(Казахская головная архитектурно-строительная Академия),
Алматы, Республика Казахстан

E-mail: [1]*larisa.brulova@gmail.com,* [2]*oksana.priemets@mail.ru*

АРХИТЕКТУРА ПОДЗЕМНЫХ ПРОСТРАНСТВ

Аннотация. Освоение подземного пространства в планировке и застройке крупных городов приобретает огромное значение из-за дефицита городских территорий, постоянного роста населения и резкого увеличения загазованности и транспортных потоков на улицах, недостаточного развития городской инфраструктуры. В условиях быстрого роста населения городов и занимаемых ими территорий, катастрофического повышения уровня автомобилизации, требований увеличения скоростей движения с одновременным повышением его безопасности проблемы сохранения опорной капитальной застройки и природного окружения могут быть решены только при условии широкого и планомерного создания и использования подземных пространств. За последние десятилетия освоение подземного пространства во многих странах мира превратилось в развитую индустрию. Она решает три главных задачи: разгружает транспортные потоки, позволяет с помощью подземных этажей возводить высотные здания и расширяет полезное пространство дома благодаря устройству эксплуатируемых помещений.

Ключевые слова: проектирование, город, пространство, архитектура, подземные комплексы, градостроительство, экология, перспектива, инновационные технологии, автомобилизация, пространство, транспорт

Underground urban studies is an area of architecture and urban planning, it is closely related to complex use of urban underground space, it must meet the requirements of modern urban planning aesthetics, technical and economic feasibility and social hygiene.

In the development of underground space it is necessary to ensure optimal conditions of work and life of people, convenient and rational population movement, increase of public landscape in the city, the formation of an aesthetically appealing environment [1—3].

The level of utilization of the underground space depends on the dimension of the city, the population concentration in its various parts, the calculated level of motorization, geological, climatic, topographic factors, techniques and technologies of work.

The development, creation and design of underground spaces are strongly influenced by the nature and content of historically formed and future construction, communication with the ground space, environmental characteristics, nomenclature of the underground buildings and modern architectural concepts of urban space organization.

The systematic use of underground space is conducted in conjunction with the surface planning and construction, with various types of existing underground structures and taking into account the subsequent stages of development of the city. Modern urban underground space includes engineering and transport construction, trade and public catering, entertainment, commercial and sports facilities and structures, objects of public utilities and storage facilities, industrial facilities, engineering equipment.

Among these buildings there are theaters, libraries, museums, educational institutions, shopping centers and sports stadiums, which are featured by considerable sizes, more complex organization of input nodes and levels, large areas of construction, the use of modern materials and planning decisions. At the same time the main advantage of the underground architecture — propriety in the relationship with the existing historical buildings, with man-made, natural landscapes and scenery (Fig. 1).

The basic principles of urban placement of underground facilities for public use include:

Fig. 1. Delancey Underground. Architects: James Ramsey, Dan Barasch. Function: Park.
Location: USA, New York, Lower Eastside. Planned date of completion: 2025 [8]

Fig. 2. PATH. Function: shopping center, offices, parking. Location: Canada, Toronto [8]

- creation of underground complexes in the public places of formation of transport interchange nodes at the intersections of highways of class I, as well as in places of their intersection with the railway lines;
- placement of underground structures in the areas of future development of the social centers of urban values;
- placement of underground complexes in the functional zones for public use [1, 4, 5].

The main task of the organization of the underground space is the use of these features in such a way as to make maximum use of the advantages of the environment, society and the economy.

The problem is solvable, and the examples of such solutions can be implemented projects in Canada, Japan, France, etc.

Within the city, the underground structures can be placed almost everywhere, having minimal impact on the natural landscape and the environment. They are protected from the direct effects of climatic factors: rain and snow, heat and cold, wind and sun. Underground facilities have high vibration resistance and acoustic insulation. And finally, it is well protected from the effects of seismic waves and ionizing radiation, which ensures their invulnerability from weapons of mass destruction (Fig. 2) [2, 6, 7].

One of the main problems that arise in the design of the underground environment for people is the need to overcome by means of architecture the feeling of being “underground” by creating a large, integral and a kind of “flowing” spaces in which the transition from one place (or level) to another is carried out with minimum consumption of time and pedestrian’s force. It is necessary not only to emphasize the reliability and durability of structures used, but along with that to create a certain impression of lightness and aesthetic appeal. For this reason a diversity of compositional methods are used, such as nuance or contrast combination of internal volumes, staircases of different in size and shape, ramps and corridors, alternating open courtyards and types of light terraced landscaping elements and small forms (Fig. 3).

The architecture of the underground space does not have a concept of the facades, so the most important instruments of its formation are the interiors, where the first factor of its formation is artificial lighting, which visually transforms the space and creates the atmosphere and relieves the discomfort of staying underground.

The artistic and aesthetic appeal of the interior is also achieved by selection of specific color combinations, plastics and textures of the respective elements (walls, floors, ceilings, etc.).

The architectural and spatial solutions of underground construction, alongside with the traditional functional factors, is strongly influenced by environmental conditions and the nature of the historical urban environment, the presence of the previously stacked communications, the basement of existing buildings, which should make an interconnected system with the new facilities under construction. They normally determine the possibility and the scale of construction, design solutions and organization of work (Fig. 4) [8, 10, 11].

At the same time, the underground construction can reduce the cost of the basements, roofs, drop some structural and architectural elements of terrestrial buildings, such as exterior window frames, internal gutters, facades and other.

In the design of objects in the underground space it is necessary to take into account the favorable operational factors, such as nonsusceptibility to climatic influences, temperature stability and relative humidity, beginning at a depth of 5–8 m [9, 12, 13].

Fig. 3. Public space instead of parking. Architects: Sid Lee Architecture + Ædifica. Location: Multifunctional public space, Canda, Quebec, Montreal. Date of completion: 2012 [9]

Fig. 4. Public commercial space. Function: Multifunctional public space. Location: Canada, Quebec, Montreal. Date of completion: 2012 [9]

According to the organization of space some typical solutions can be distinguished among the underground buildings:

1. Building under a green roof and Dike building. For examples the Museum of Steel in Monterrey (Mexico), by the architect Nicholas Grimshaw, built in 2007 and the Nelson Atkins Museum of Art in Kansas City (USA), built by the architect Steven Holl in the same year.
2. Building-plaza. The building is buried in the ground at full height, and the roof is organized as a pedestrian plaza or square. The lamps, light guides and atriums solve the lighting in such buildings. Examples of such kinds of underground spaces are a new part of the Louvre in Paris (architect Yo Ming Pei, 1989), a shopping complex at the Manege Square in Moscow (architect Victor Steller, 1995–1997), Joanneum museum in Graz.
3. Terraced building. The building is organized in the form of terraces, representing multi-level open space, serving as a recreational zone. A striking example is the Les Halles marketplace in Paris by architect Claude Vasconi, built in 1986. Another building, referred to this type — Oakland museum of California by the architect Kevin Roche, built in 1969.
4. “Light ring” building — a building that is buried in the ground and around the perimeter of a pit or a lantern, which is organized through the natural light of the lower floors [7].

Thus, the identification of architectural techniques used in the design of the considered buildings, allow extending the set of architectural tools and serving as a basis for the development of regulatory documents for the design of underground spaces.

However, it is necessary to overcome many difficulties of a psychological nature. Modern man spends more time in a confined space, with significant disadvantages compared with the natural environment. Such situation can be resolved due to smart organization and planning of the underground space, technical and aesthetic design of the interior space (safety, location, ease of use, ease of orientation, visual communication with the surface, creation of a different climate, a relatively frequent change of interior, organization of special acoustic effects, compliance of the light and color modes) [3, 6, 14].

The increase of architectural and artistic qualities of design, construction and operation of multi-level space becomes relevant.

The period of time and the circumstances dictate the necessity of the transition from horizontal to vertical zoning of urban space, which is able to provide a formation of comfortable residential and industrial environment on the basis of spatial organization of the whole system of objects, as an entire organism, including housing and all the required social, industrial and engineering infrastructure created underground. In the contemporary science of urban studies it is called “a complex development of the urban underground space” (Fig. 5).

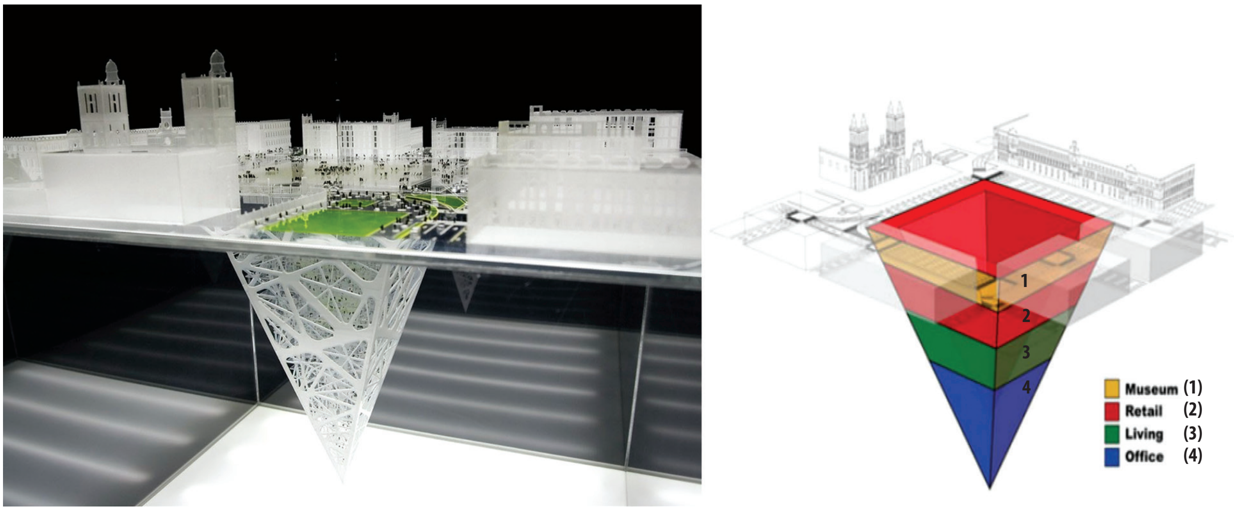

Fig. 5. Multifunctional complex under a plaza. Architects: BNKR Arquitectura. Function: retail, parking, leisure, offices. Location: Mexico, Mexico city. Planned date of completion: unknown [15]

The progress inexorably moves forward and all the things, without which we could easily go on in the past, nowadays seem to be vital. Based on the experience of the foreign countries, it can say that due to special engineering arrangements and detailed implementation the fitting of underground facilities becomes inevitable [14, 16].

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